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Introduction

Introduction

Coinage of the term whiplash is claimed by H.E. Crowe in relation to his presentation of eight cases of neck injury to a medical meeting in San Francisco in 1928.[1] The term refers to a specific movement of the head due to a rear-end motor vehicle collision. Later the term whiplash was used to refer to the complex of symptoms itself. In 1995, the Quebec Task Force introduced the term Whiplash Associated Disorder (WAD) to capture the wide variety of symptoms attributed to whiplash by that time.[2] Other terms used in the literature are late or post-whiplash syndrome, to indicate symptoms after a whiplash accident or movement.

Although the majority of patients show spontaneous recovery within the first few months after a traffic accident, in as many as 40 percent of cases acute complaints lead to a chronic syndrome with neck pain and often accompanying cognitive complaints.[3] To date no somatic injury has been identified that can explain the chronic symptoms, which are thereby generally identified as medically unexplained, and this has given rise to various views, studies and controversies regarding their possible somatic, psychological or psychosomatic nature.

In 1964, Crowe himself stated that he regretted the coinage.[1] He wrote that the expression was intended to be a description of motion, but that it had become accepted by physicians, patients and attorneys as the name of a disorder, and that this misunderstanding had led to its misapplication by many physicians and others over the years. Indeed, when Crowe introduced the term 'whiplash injury' in 1928 he could hardly have imagined to what medical and social controversy it would lead.

Over the last decades chronic neck pain has become a common complaint following motor vehicle accidents in various countries. Often the neck pain is accompanied by cognitive and other complaints. Over the years the symptoms reported have become increasingly varied. The accident is still the prerequisite to the complaints and has become defined in ever broader terms until today any accident can be considered a possible 'whiplash accident'. [2]

The main feature of whiplash is neck pain. There may be a wide variety of other symptoms accompanying the neck pain, but the presence of neck pain is usually considered to be a requirement for the diagnosis of whiplash. Because the term 'whiplash' itself is actually a description of a movement, it is poorly defined with regard to accompanying symptoms, and due to its possible dysfunctional connotation many even choose not to use the word at all. An alternative name might be post-traumatic neck pain (PTNP). This name clearly indicates that neck pain is the central symptom and that it has a post-traumatic origin, although some may find this to be too narrow a definition.

Throughout the studies reported in this thesis, the term whiplash and post-whiplash

syndrome are used because of their familiarity to physicians and other potential readers, although the appropriateness of these labels may be subject to discussion.

Whiplash in the Netherlands

Dutch research and scientific publications

Dutch-language scientific articles on whiplash are relatively scarce. One of the first articles published was by Jongkees in 1974.[4] In his 'clinical lesson' he asked that attention be given to post-traumatic symptoms of the neck, especially dizziness. He stated that in many cases psychosomatosis was unjustly suspected, and that the symptoms could be resolved by the treatment of the neck muscles. In 1976, Braakman presented a literature review.[5] He described possible injuries due to the 'whiplash-mechanism' and stated that after the signs of soft-tissue injuries had disappeared, physical treatment was contra-indicated and would only keep memories of the accident alive. He added that treatment in the chronic phase should emphasize on reassurance and if necessary confront the patient with his or her fear.

In a second 'clinical lesson', in 1981, Jongkees again presented his view on whiplash symptoms.[6] Ten years later Van Wijngaarden described symptoms in 200 patients who were referred for an expert neurology assessment.[7] In the same journal Kortbeek presented a review.[8] In 1997, Ronnen et al. republished in Dutch their previously internationally published paper on the indications of MRI in cases of acute whiplash trauma.[9,10] In a 'clinical lesson' in 2002, Reinders urged medical doctors to take psychological factors into account, and to use a bio-psychosocial model as an explanation for the complaints.[11] In 2004, Vendrig et al. presented an overview of the current knowledge regarding prevention and treatment, based on published evidence.[12]

Of course there have also been many articles on neck pain published by Dutch authors in English, many of which are found in dissertations. Without striving for completeness a short overview is presented below.

The main focus of the thesis by Hoving ('Neck pain in primary care', 2001) was on the effectiveness of commonly applied interventions for patients with neck pain in primary care.[13] A randomized clinical trial using the short and long-term outcomes of 183 patients with non-specific neck pain receiving either manual therapy, physical therapy or GP care was presented. Hoving concluded that manual therapy showed a beneficial effect compared to physical therapy and GP care.

The main objective of the thesis by Ariëns ('Work-related risk factors for neck pain', 2001) was to identify work-related physical and psychosocial risk factors for neck pain.[14] The results of a large, three-year prospective cohort study in an occupational setting aiming to identify work-related risk factors for musculoskeletal complaints were reported.

The results showed a relationship between prolonged sitting and neck flexion, and neck pain. In addition, the results presented showed that high quantitative job demands, low job control (decision authority) and low co-worker support were also risk factors for neck pain.

Versteegen ('Sprain of the neck & whiplash associated disorders', 2001) studied epidemiological and other consequences of neck sprain and Whiplash Associated Disorders (WAD).[15] In this thesis, data from 25 years of emergency room visits to the University Hospital Groningen due to neck sprain were studied. Over the 25-year study period a steady increase in patients with neck sprain was observed. Personal circumstances such as life-events and their relationship with the course of the complaints were also studied. Albeit suffering from a low response, it appeared that life-events did not play a role in the development of whiplash associated disorders.

The main aims of the thesis by Nederhand ('Muscle activation patterns in post traumatic neck pain', 2003) were to clarify the characteristics of 'musculoskeletal signs' in acute and chronic post-traumatic neck pain patients and to determine its clinical relevance in relation to the management of acute and chronic post-traumatic neck pain patients.[16] The studies were the first to prospectively investigate the muscle activation patterns of acute neck pain, following patients until they recovered or developed chronic disability. The results did not demonstrate that these muscle activation patterns played a significant role in the transition from acute to chronic pain. Furthermore, it concluded that it was not the injury severity that determined the muscle activation pattern but rather the perception of the symptoms.

The general aim of the thesis by Scholten-Peters ('Whiplash and its treatment', 2004) was to gain insight into the effectiveness of a conservative treatment provided by general practitioners and physiotherapists for patients with whiplash associated disorder.[17] Additionally, possible prognostic factors associated with poor recovery were also studied. Apart from systematic reviews of the effectiveness of conservative treatments and prognostic factors, a randomized clinical trial was also conducted, consisting of 150 patients, which compared GP care and physiotherapy. The study revealed no significant differences between the primary outcome measures of pain and work activities at 12 and 52 weeks after the accident.

The main aim of the thesis by Blokhorst ('State-dependent factors and attention in Whiplash Associated Disorder', 2005) was to investigate the relationship between state-dependent factors such as headache, neck pain, fatigue or distress and attention.[18] It concluded that the health state of WAD patients is significantly related to attentional functioning. Treatment of chronic patients should therefore focus on pain as well as on stress management in the broadest sense, implying for example reduction of negative emotions (for example, post-traumatic stress symptoms, phobic reactions).

The general aim of the thesis by Vos ('Acute neck pain in general practice', 2006) was to gain an insight into the clinical course of patients with acute neck pain once they had visited their general practitioner.[19] In a prospective cohort study with a one-year follow-up the clinical courses of 187 patients with acute neck pain was studied. A subgroup analysis focused on 42 patients who had been involved in motor vehicle accidents (MVAs). This group showed higher levels of headache or neck pain and neck disability at baseline and follow-up, compared to neck pain patients not reporting a MVA. It was concluded that exposure to MVAs constitutes a relevant subgroup of patients in general practice with higher levels of continuous neck pain and disability.

Vangronsveld ('By accident. Pain catastrophizing and fear of movement in patients with neck pain after a motor vehicle accident', 2007) investigated the association between the fear-avoidance model and acute and persisting neck pain after a motor vehicle accident.[20] Using different methodological designs, including theory-based predictive variables and measuring multiple outcome measures, the results revealed an intricate interplay between pain, anger and fear. Although some of the results were in favour of the Fear-Avoidance model, they also highlighted the importance of including all variables of the model in research since all of them may be of specific influence in different stages of pain. Although included for explorative reasons, baseline anger was the strongest predictor for the long-term outcomes, in terms of post-traumatic stress symptoms, but also for disability, depression and quality of life.

The thesis by Pool ('Neck pain: "a pain in the neck"? A study of therapeutic modalities and clinimetrics', 2007) presented an overview of interventions.[21] Furthermore, the design and results of a randomized clinical trial comparing a behavioural graded activity programme with manual therapy for patients with non-specific sub-acute neck pain were reported. The results revealed a marginally but statistically significant difference on various outcome parameters in favour of the behaviour graded activity programme. It was concluded that there were only marginal, but not clinically relevant, differences between the two programmes studied. In a second, prospective study the prognostic value of psychological factors on short and long-term outcomes was investigated. No core set of prognostic psychological factors that predict the short and long-term outcomes of sub-acute neck pain could be identified. Finally, the Minimal Clinically Important Change (MCIC) on the Neck Disability Index (NDI) and the Numeric Rating Scale (NRS) for pain in patients with neck pain was assessed.

The primary objective of the thesis by Voerman ('Musculoskeletal neck-shoulder pain. A new ambulant myofeedback intervention approach', 2007) was to obtain insight into the effects and mechanisms of a new ambulant myofeedback intervention approach in patients with persistent neck and shoulder pain.[22] It concluded that ambulant myofeedback training is beneficial in reducing neck and shoulder pain as well as disability in patients

with complaints related to work or Whiplash Associated Disorder. Although the working mechanisms of myofeedback are not yet fully understood, cognitive behavioural factors are thought likely to be more important than muscle activation patterns.

Epidemiology

There are no reliable up-to-date figures on the epidemiology of whiplash in the Netherlands. Wismans conducted an investigation into the incidence of whiplash in the Netherlands in 1994, with the goal of gaining insight into the problem of whiplash specifically in the Netherlands.[23] The study included data from various sources, for example police and hospitals, the social security office, and motor vehicle and medical insurers. The data showed low incidence numbers from all sources except liability insurance company data. It was estimated that a total incidence of 15,000 to 30,000 new patients with whiplash per annum was plausible.

Versteegen et al. published incidence figures from the emergency room of the University Medical Center Groningen (UMCG) from 1970 to 1994.[24] The incidence curve suggests an epidemic-like explosion in the number of emergency room visitors with neck sprain after a car accident, although the absolute numbers remained relatively low, with a maximum of 122 patients per year. However, unpublished data on UMCG emergency room visitors with neck sprain after 1994 show a dramatic decline in numbers, suggesting that the epidemic has abated. A recently published Dutch study which failed because of insufficient patients, confirms that the number of patients seeking help for cervical complaints after a motor vehicle accident seems to be rapidly declining in the Netherlands.[25] However, everyday practice in the liability claims departments of insurers does not confirm this trend, although, again reliable nationwide figures do not exist.

A report by the Comité Europeén des Assurances (CEA) and the Association for the Study and Compensation of Bodily Injury (AREDOC) from 2004 shows that according to insurance companies the Dutch incidence of new minor cervical trauma claims is 20,000 per year.[26] According to the CEA a rise in cervical injury claims was first noted in 1999. In the above-mentioned incidence curve of UMCG emergency room visitors, the largest incidence increase occurred 5 to 10 years before 1999, suggesting that claim incidence may show a delayed reaction.

Whiplash can be a cause of work disability. Within the Dutch social security system, employees are insured for long-term work disability by the WIA (WAO). Because of the privatization of the first two years of work disability since 2005, there are currently no data on diagnosis-related incidence figures in the first two years of disability. Earlier figures from the Social Security Office (UWV) show that in 2002, 1,473 new claims for long-term (> 1 year) work disability were granted and, in total, 43,523 (5.4%) work-disabled employees received compensation because of whiplash. There are no data on privately insured self-

employed workers.

All in all, the literature suggests that whiplash is a major problem in the Netherlands, leading to a high number of work-disability and liability claims. Furthermore, there is some evidence that the epidemic of the early 1990s has reached its peak.

Research on Whiplash

The major body of research on whiplash focuses on complaint recovery. However, whiplash can also lead to long-term sick leave and the granting of disability pensions. Work is a functional outcome parameter and responsible for a major part of the socioeconomic costs of whiplash.[27] Research has shown that the costs of sick leave and disability pensions are much higher than those of acute medical care, demonstrating that these parameters are of paramount importance when evaluating the consequences of neck pain after motor vehicle accidents.[28]

On several occasions whiplash has been compared to railway spine, a nineteenth-century complex of various complaints later labelled psychosomatic in nature.[29,30] In railway spine, people experienced unexplained symptoms after railway accidents, and later after travelling in a train. Fear of train accidents were thought to have caused increased anxiety levels, giving rise to psychosomatic complaints fuelled by liability claims. Indeed the similarities are striking, making it painfully clear that we should learn the lessons of history to avoid repeating it. The history of post-traumatic neurosis proves to be very educational and a prerequisite for anyone wanting to understand whiplash.[29]

Several articles have addressed the apparent differences in epidemiological figures for whiplash and its associated symptoms across different countries. A study by Schrader et al. led to much discussion, while a later published and methodologically more profound study by Oubelieniene is often overlooked.[31,32] Both studies investigated neck pain after traffic accidents in Lithuania. The findings suggested that in Lithuania there is no evidence of disabling or persistent symptoms as a result of car accidents. The main conclusion was that in a country where there is no preconceived notion of chronic pain arising from rear-end collisions, and thus no fear of long-term disability, and usually no involvement of the therapeutic community, insurance companies or litigation, whiplash symptoms are self-limiting, brief, and do not seem to evolve into a chronic syndrome. The studies gave rise to several articles and editorial comments regarding culture-dependent factors.

On reviewing the literature on whiplash it seems that it is apparently not a worldwide condition, but pertains mainly to some Western European countries, the US, Canada and Australia. Considering that accidents occur everywhere, this very fact suggests that the nature of the syndrome is culture-dependent

Since 1945, when Davis initiated the large body of medical literature on whiplash, many

articles have been published on the subject. In 1995, the Quebec taskforce assessed about 10,000 articles on whiplash, and recently, in 2008 the 'Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders' assessed 31,878 citations on neck pain, demonstrating that it is a major subject of research.[2,33] However, a striking fact is the shear variation in the content of these articles. Along with articles on the relevance of head restraints, safety belts, or crash-related parameters, there are articles on anxiety, psychiatric symptoms and cultural aetiology, sometimes in the same journal. For a non-expert in the field the literature on whiplash must seem very confusing, and lacking a clear or uniform line or direction of research. This profound heterogeneity of the literature on whiplash is a sign of the widely different opinions regarding its aetiology and hence its prevention, diagnosis and treatment.

The literature on whiplash can roughly be divided into two research directions. The first can be described as the physical or somatic direction. This line of research looks for somatic signs or injuries which could possibly explain the persisting symptoms. There are many articles on the physical aspects of car crashes, looking for the car crash parameter or safety precaution which can predict or prevent the occurrence of whiplash complaints. Diagnostic procedures in search of a somatic injury are described. The interventions investigated are often invasive, ranging from manipulations or injections with various substances to extensive operations on cervical vertebrae. However, studies on somatic or physical predictors have not convincingly shown accident parameters, headrest use etc. to be reliable predictors. In a recent systematic review of physical prognostic factors it was concluded that the medical literature reviewed showed poor methodological quality, highlighting the need for better-quality research. However, the perceived pain was found to have a central role in the development of chronic complaints.[34] In various studies, early neck pain severity is found to be associated with longer-term neck pain, for example, occurring after one year. Because no injury is identified that can explain the perceived pain and other complaints, the somatic perspective provides no clear view on the aetiology of symptoms.

The second research line is psychological in nature. It builds on the history of post-traumatic neurosis, and the large body of research on psychological principles in other chronic pain conditions such as low back pain. It includes articles on cultural aspects and the role of psychological parameters such as anxiety, depression and personality characteristics. This psychological line of research shows that various psychological variables seem relevant, although to date no single psychological parameter stands out as *the* cause of whiplash. In a recent systematic review of psychological factors it was concluded that self-efficacy and post-traumatic stress may be associated with chronic complaints, although again, lack of conclusive findings and the poor methodological quality of the studies reviewed highlights the need for better-quality research.[35]

Obviously, it should be ensured that two different syndromes or medical entities are not investigated under the same name. A car crash, or any accident for that matter, can result in an injury to the cervical spine. Investigation of the cervical spine is therefore standard procedure in any emergency room investigation after a car crash of sufficient energetic size. While there is no doubt that a car crash can lead to serious injury of the cervical spine, it is also obvious that not every patient with persisting complaints after a car crash has a cervical injury. Persisting symptoms can have many causes, and when an injury is ruled out, it is feasible to move on to other possible diagnoses. Some physicians and other health-care workers persistently concentrate on the physical aspects of whiplash complaints. Obviously, an injury can cause physical complaints, but this of course does not imply that all physical complaints are thus caused by an injury. Knowledge of the psychosomatic processes and the role of culture-related factors is of paramount importance when dealing with unexplained symptoms.[36] Fortunately, increasing attention is being paid to the cultural and psychological aspects of physical complaints in medical curricula and education.

The evidently large differences between countries and the very low accident velocities that are often reported, with acceleration levels usually experienced in everyday life, nevertheless resulting in severe, long-lasting and incapacitating complaints, indicate that the physical aspects alone cannot explain all persisting symptoms.[37-39] In this thesis therefore the focus of research is on psychological factors.

Psychological aspects of whiplash

In contrast to research on low back pain, a recent review of predictive factors for developing chronic whiplash complaints revealed only a limited predictive value for psychosocial variables.[35,40] Other studies have reported that neither personality traits nor psychopathological symptoms can predict outcomes. However, these studies are known to have design and other methodological deficiencies that preclude them from effectively addressing the issue of psychological factors in a meaningful way.[35,41,42]

In research on low back pain it is well established that psychological factors are related to chronic pain and disability.[43] Given the fact that in chronic whiplash there is also chronic musculoskeletal pain related to the spine without identification of a somatic cause, it seems reasonable to assume that psychological parameters can also play a role in the aetiology and course of persisting whiplash symptoms.

An important factor to consider is the fact that neck complaints in whiplash are caused, or at least experienced, after an accident. An accident is often a frightening or terrifying experience. That such an experience could lead to anxiety of any kind is not surprising. Considering the known influence of anxiety on somatic complaints, this alone

makes studying anxiety in relation to unexplained somatic symptoms very interesting. Dysfunctional coping styles could further fuel anxiety and psychosomatic mechanisms, thereby possibly leading to enhanced and a prolonged course of symptoms. Anxiety related to avoidance, such as in kinesiophobia or fear of (re)injury could play an important role, considering its apparent relevance in other chronic pain syndromes. Post-traumatic stress disorder is also a specific kind of anxiety related to the experience of a (life) threatening event. Since by definition the neck complaint occurs after an accident, there has been a potentially threatening event. It could be expected that the post-traumatic stress anxiety symptoms are related to the severity of the somatic complaints and could play a role in the prognosis of neck pain after a motor vehicle accident. The culture-dependent nature of whiplash also gives cause for discussion. Patients' beliefs regarding the origin or cause of the complaints could be relevant considering the catastrophic interpretation that may be involved in the early negative expectations regarding the course and prognosis of neck pain after a motor vehicle accident.

Coping

Coping can be defined as the way in which someone behaviourally, cognitively and emotionally adapts so as to manage external or internal stressors.[44] The accident itself, as well as the pain afterwards, can be considered an external stressor and therefore as requiring coping efforts. Coping has been conceptualized in various ways, often dependent on the questionnaire used to index the construct.

The concept of coping has also been the subject of research in relation to chronic low back pain. The literature available shows an association between coping style and prognosis and outcome of treatment in low back pain.[45;46] Furthermore, in whiplash the onset of complaints is often related to a stressful accident, which could put a higher demand on adequate coping skills. At the same time, the experience of neck pain can be much more frightening than low back pain, which is more common, and usually known to be benign in nature. Depending on the cultural context, acute neck pain can be associated with persistent complaints and disability, making the complaints an even more potentially terrifying experience. Dysfunctional coping styles could thus lead to enhanced pain experience or catastrophic interpretations of symptoms, thereby contributing to a bad prognosis.

Kinesiophobia & catastrophizing

In relation to low back pain, the fear-avoidance model was developed to provide an integrated model of the risk factors known to be associated with pain.[47] Central to this model is the concept of the fear of pain. In this model, catastrophizing leads to pain-related fear, leading to avoidance behaviour, including the avoidance of movement and

physical activity. Studies suggest that an excessively negative orientation toward pain catastrophizing and fear of movement/(re)injury (kinesiophobia) are important in the aetiology of chronic symptoms.[48] In low back pain, fear-avoidance beliefs are identified as risk factors for chronic low back pain, suggesting that these factors play a causal role.

Another interesting aspect of kinesiophobia is the fact that patients with chronic low back pain who retrospectively reported a sudden traumatic pain onset exhibited more kinesiophobia than patients who reported that the pain had started gradually.[49] Since in the case of whiplash the onset of pain is often described as sudden, this may set the stage for developing kinesiophobia, which in turn may contribute to a chronic course.

Pain catastrophizing refers to an exaggerated negative orientation towards actual or anticipated pain.[50] Earlier research has found that the habitual tendency to make catastrophic interpretations of pain is associated with a heightened pain experience in various patient groups.[51] Furthermore, catastrophizing has been associated with heightened disability in chronic pain, independent of the level of actual physical impairment.[52-54]

Causal beliefs

In the above-mentioned fear-avoidance model, the pathway from pain experience to fear, anxiety and avoidance, leading ultimately to disuse and disability, is moderated by catastrophizing and threatening illness beliefs. Causal illness beliefs can be defined as the patient's ideas about the origin or cause of the symptoms or illness experienced.

The causal beliefs of the patient seem very relevant in relation to the persistence of complaints when no organic cause has been identified. When patients are diagnosed with an illness they generally develop an organized pattern of beliefs about their condition. These illness perceptions or cognitive representations directly influence behaviour parameters and the emotional response.[55]

In chronic fatigue syndrome, for example, it has been found that somatic illness beliefs are associated with increased symptoms and functional impairment, poorer subjective and objective outcomes and a poor prognosis.[56,57] In somatoform disorders, organic causal attributions are associated with a need for medical diagnostic examinations, increased expression of complaints and body scanning.[58] In addition, inadequate illness beliefs were found to be associated with heart-focused anxiety.[59]

From the literature on whiplash it can be deduced that there may be many different ideas about its cause held by health professionals and consequently patients. Causal beliefs lead to expectations regarding the course of complaints. Negative expectations could give rise to avoidant behaviour, leading to the avoidance of movement and physical activity, and ultimately leading to disuse and a heightened state of fear. When the cause of acute myogenic neck complaints is attributed to a severe, for example, neural

or irreparable cause, dysfunctional beliefs and expectations arise. Therefore, given the possible importance of causal attribution, dysfunctional beliefs may play an important role in the prognosis of whiplash.

In the large body of research on whiplash its cultural dependence is often the subject of discussion. The fact that whiplash only seems to occur in a restricted number of countries and runs an apparently different course in various countries seems to imply that the cultural context is a major factor to be considered.[31,32,60,61] However, the actual nature of that cultural context has never been subject to research. Causal illness beliefs are shaped by cultural factors. Beliefs and expectations regarding whiplash were found to vary profoundly across countries, thereby providing a cultural parameter relevant to the prognosis of muscular neck pain.[61-64]

The medical interpretation and explanation of myogenic neck pain after a motor vehicle accident, provided by general practitioners or emergency room staff, as well as commonly held knowledge and culture-defined ideas, may give rise to dysfunctional illness beliefs regarding the cause of the neck complaints, which in turn may cause catastrophic expectations that lead to a chronic course.[37]

Additionally, it is conceivable that pain catastrophizing leads to more dysfunctional causal beliefs. The tendency to attribute neck complaints to irreparable or severe causes in its turn may elicit catastrophic interpretations of potentially benign muscular symptoms. Catastrophizing and dysfunctional causal beliefs could thus lead to a negative spiral, augmenting symptom severity and discharging into irrational expectations regarding the course of the symptoms and disability, fuelling a chronic course.[47,65]

Post-traumatic stress disorder

Post-traumatic stress disorder is an anxiety disorder which consists of three symptom clusters: re-experiencing, avoidance and hyperarousal symptoms. Post-whiplash syndrome and post-traumatic stress disorder are both relatively common conditions following traffic accidents.[66-68] As many as 23 percent of traffic accident victims are reported to have developed post-traumatic stress disorder, which is known to have high psychiatric and medical comorbidity.[69-72]

Earlier research has provided preliminary evidence to indicate that post-traumatic stress symptoms (that is, re-experiencing and avoidance symptoms) are related to whiplash.[73-75] More specifically, the re-experiencing and avoidance subscales of the Impact of Event Scale were found to be associated with relatively persistent whiplash complaints at six month follow-up. Unfortunately, this study tested only two of the three post-traumatic stress disorder symptom scales; the hyperarousal symptom cluster scale was not included. Nonetheless, these hyperarousal symptoms may be highly relevant to the proper understanding of the relationship between post-traumatic stress disorder and

whiplash.[76] An other study considered all three post-traumatic stress disorder symptom scales but recruited its participants solely from an emergency room, thereby possibly biasing the results towards patients who were more frightened or whose injuries were more serious.[77]

Since anxiety is an important feature of post-traumatic stress disorder and is known to influence the perception and experience of pain, post-traumatic stress symptoms may alter the perception and experience of acute neck pain.[78] Post-traumatic stress symptoms may give rise to increased anxiety and vigilance levels, thereby fuelling catastrophic, dysfunctional interpretations of acute neck pain. Finally, post-traumatic stress disorder shares several symptoms with whiplash, including insomnia, irritability and cognitive problems. Therefore it is also conceivable that post-traumatic stress symptoms are erroneously attributed to whiplash.

Outline of the thesis

In this thesis five descriptive studies will be presented that are cross-sectional and (prospective) longitudinal in nature. The general aim of these studies is to determine the consequences of whiplash for work disability and the relationship between psychological parameters and the prognosis.

Traffic accident victims who had initiated compensation claim procedures for personal injury with a Dutch insurance company were asked to participate in the various studies. The letter of invitation clearly communicated that the study was independent of the compensation procedure. Participants were assessed at one, six and twelve months after their accident using relevant questionnaires. Because of the available cross-sectional data, subgroups could be analysed at any of the three moments. The longitudinal data could be used to analyse predictive characteristics and the temporal order of events. To keep the total number of questionnaires small, different samples were used for each study, with the exception of the study on work disability (Chapter 2), in which the sample was formed by combining the other four.

Following this introductory chapter, **Chapter 2** of this dissertation will present a study on whiplash and work disability. In a prospective cohort study, the symptoms and work-related factors from 879 participants with neck pain after a motor vehicle accident were investigated and followed up after six and twelve months. The relationship between whiplash, its symptoms and work characteristics will be analysed and described.

In **Chapter 3**, a prospective cohort study of 363 participants with neck pain after a motor vehicle accident, will be described, with a follow-up of one year. Coping styles employed within the first month will be investigated and the associations with the course of physical and cognitive symptoms studied.

One of the concepts derived from the fear-avoidance model is kinesiophobia, or fear of

movement and (re)injury. In **Chapter 4**, we will describe a prospective cohort study of 367 participants with neck pain after a motor vehicle accident. The predictive value of early kinesiophobia in relation to the course of whiplash symptoms will be studied.

Chapter 5 contains a prospective cohort study of 240 participants with neck pain after a motor vehicle accident. The relationship between post-traumatic stress disorder and its symptoms, and the severity and course of whiplash at one, six and twelve months will be studied.

In **Chapter 6**, a prospective cohort study of 140 participants with neck pain after a motor vehicle accident will be presented. Early pain catastrophizing and causal beliefs in relation to the severity and prognosis of whiplash will be investigated.

Finally, in **Chapter 7** the results of the various studies will be integrated and discussed.

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